PATENT ABSTRACTS OF JAPAN

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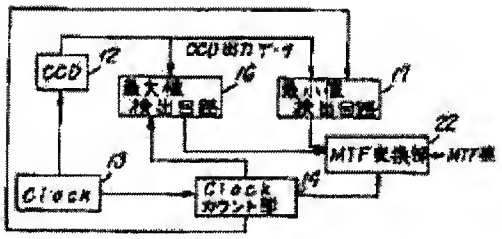
(54) METHOD FOR MEASURING MTF

(57)Abstract:

PROBLEM TO BE SOLVED: To measure an MTF immediately and adjust synchronously with the measurement of the MTF, by obtaining the MTF of an object to be detected, by hardware in real time.

SOLUTION: An output data of a solid scanning element 12 to an effective part of a chart is sent to a maximum value detection circuit 16 and a minimum value detection circuit 17. A clock-counting part 14 makes the maximum value detection circuit 16 and the minimum value detection circuit 17 output a maximum value and a minimum value of the output data every predetermined time. The maximum and minimum values are converted to an MTF by an MTF conversion part 22. Accordingly, the MTF of an object to be detected is obtained in real time by hardware.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the MTF measuring method which calculates MTF of the specimen using the chart which has a pattern of predetermined space frequency.
[0002]
[Description of the Prior Art]An MTF measuring method has an MTF measuring method which uses 0 spatial frequency, and an MTF measuring method which does not use 0 spatial frequency. The MTF measuring method which does not use 0 spatial frequency, Through the specimen, image formation of the image of the chart which has a pattern of predetermined space frequency is carried out to CCD (charge coupled device), photoelectric conversion is carried out to it, and it is MTF=(MAX-MIN)/(MAX+MIN-2xD) from the maximum MAX, the minimum MIN, and the dummy-bits data D of output data of this CCD.
MTF of the specimen come out of and defined is calculated.
[0003]To JP,S56-2516,A, the MTF measuring method which uses the white level and black level of 0 spatial frequency is indicated. In this MTF measuring method, through the specimen, image formation of the image of the chart which has a pattern of predetermined space frequency is carried out to CCD, photoelectric conversion is carried out to it, and as shown in drawing 5, the serial signal from this CCD is digitized by A/D converter 1, and is stored in RAM3 via the input/output port 2. Micro CPU4 performs digital calculation with the data in RAM3, and White level a and black level b of a required chart part, That is, it asks for white level A near the average value a of the signal of the several bits maximum of a white level field, the average value b of the signal of the several bits minimum neighborhood of a black level, and 0 spatial frequency, and black level B, and MTF of the specimen is calculated by MTF={(a-b)/(a+b)/(A-B)/(A+B)} x100% of an operation. If bit detection of two or more a, b, A, and B is carried out, respectively and each of those average value is substituted for the above-

mentioned formula, the calculation precision of MTF will improve.
[0004]In the MTF measuring method which uses the white level and black level of 0 spatial frequency, when performing MTF measurement of all the image height, three kinds of charts of the white level of 0 spatial frequency and a black level, and the predetermined frequency for MTF measurement are required as a chart, and these charts are switched and used.
[0005]In measuring three colors of the specimen, for example, red, (henceforth [R]), and blue (henceforth [B]) and green (henceforth [G]) MTF, In the above-mentioned MTF measuring method, MTF is independently calculated about the output data of each color of this three-line CCD using three-line CCD which carries out photoelectric conversion of each color component of a chart image as CCD.
[0006]
[Problem(s) to be Solved by the Invention]Even if the MTF measuring method which uses the chart which has a pattern of predetermined space frequency comprises hardware like an MTF measuring method given [above-mentioned] in JP,S56-2516,A, about the MTF operation, software is performing it. For this reason, it is difficult to perform an MTF operation at high speed, and had become a neck at the time of measuring MTF at high speed.
[0007]Since the white level and black level of 0 spatial frequency are not used for the MTF measuring method which uses the chart which has a pattern of predetermined space frequency, it cannot perform highly precise MTF measurement in the MTF measurement using three-line CCD. In the MTF measuring method which uses the white level and black level of 0 spatial frequency, there was a problem which can switch a chart or cannot take MTF of all the image height. An object of this invention is to provide the MTF measuring method which can realize high-speed and highly precise MTF measurement.
[0008]
[Means for Solving the Problem]In order to attain the above-mentioned purpose, the invention according to claim 1, In an MTF measuring method which carries out image formation of the image of a chart which has a pattern of predetermined space frequency to solid scanning elements, carries out photoelectric conversion to them through specimen, and calculates MTF of specimen from output data of these solid scanning elements, Output data of solid scanning elements to an effective part of said chart is sent to a maximum detector circuit and a minimum value detecting circuit, By making the maximum and the minimum of said output data output for every fixed time by a clock counting part to these maximum detector circuits and minimum value detecting circuits, and changing this maximum and minimum into MTF in an MTF converter, MTF of specimen is calculated in real time by hardware.
[0009]The invention according to claim 2 uses solid scanning elements of 3 classification by color which performs photoelectric conversion of three colors to an effective part of said chart as said solid scanning elements in the MTF measuring method according to claim 1, From

output data of solid scanning elements of these three classification by color, for every color A maximum detector circuit and a minimum value detecting circuit, The maximum and the minimum of said output data are calculated for every fixed time by a clock counting part, and it changes into MTF with a conversion factor which set up independently the maximum and the minimum of these three classification by color for every color in an MTF converter.

[0010]

[Embodiment of the Invention]Drawing 1 shows the example of 1 embodiment of the MTF measuring device which applied the invention according to claim 1, drawing 2 shows the concrete composition, and drawing 4 shows an overall hardware process flow. The chart 11 which has a pattern of only predetermined space frequency without the white level and black level of 0 spatial frequency as shown in drawing 3 is illuminated with a light source, and image formation is carried out on the solid scanning elements 12 which consist of CCD through the specimen which the image of the chart 11 becomes from the optical system of a tested lens etc. CCD12 repeats the image of the chart 11, scans and (scan) carries out photoelectric conversion, and outputs it by a time series.

[0011]By the way, for the MTF measuring method which uses the white level and black level of 0 spatial frequency. From the white level and black level of the maximum of a required chart part and the minimum in the CCD output data to the chart which has a pattern of predetermined space frequency, and 0 spatial frequency to MTF=(maximum-minimum)/{(black level of white level 0 spatial frequency of 0 spatial frequency)} ... (1)

There is a method of calculating MTF of the specimen come out of and defined.

[0012]The data of the white level of 0 spatial frequency and the data of the (maximum + minimum) / 2 <the median of width> have correlation here, (1) since data of black level of 0 spatial frequency has dramatically small absolute value and contribution to (1) type is low type is MTF=(maximum-minimum)/{(maximum + minimum) /2}... (2)

It is possible for it to be alike and to replace.

[0013]Then, the chart 11 which has a pattern of only predetermined space frequency without the white level and black level of 0 spatial frequency is used for this example of an embodiment, and it calculates MTF of the specimen by the MTF operation of (2) types from the maximum and the minimum of output data of CCD12 to the effective part of the chart 11. That is, CCD12 is driven with the clock from the clock generation part (Clock) 13 at the set-up incorporation time, and incorporates and carries out photoelectric conversion of the image of the chart 11. The clock (Clock) counting part 14 counts the clock from the clock generation part 13, and generates the gating signal for output timing.

[0014]The counter circuit 15 where this clock counting part 14 consists of an IC for counters is used, and, as for this IC15 for counters, TTLIC is used. If IC15 for counters is TTL, it is more effective to use high-speed things, such as F type. The comparator circuit 18 for maximum

detection and the comparator circuit 19 for minimum detection where the maximum detector circuit 16 and the minimum value detecting circuit 17 consist of a comparator IC, and the flip-flop circuit 20 for a maximum latch and the flip-flop circuit 21 for a minimum latch are used.
[0015]As for the comparator circuit 18 for maximum detection, and the comparator circuit 19 for minimum detection, it is also effective to use ROM, RAM, etc. instead of comparator IC. If the flip-flop circuit 20 for a maximum latch and the flip-flop circuit 21 for a minimum latch are TTL, it is more effective to use high-speed things, such as F type. The A/D conversion of the output data of CCD12 to the effective part of the chart 11 is carried out by the A/D converter which is not illustrated, The maximum detector circuit 16 and the minimum value detecting circuit 17 detect the maximum and the minimum of output data of the above-mentioned A/D converter within the set period (arbitrarily time which can be set up) set up by the clock counting part 14 with the gating signal for output timing from the clock counting part 14.
[0016]The flip-flop circuit 20 for a maximum latch, and the flip-flop circuit 21 for a minimum latch, It holds until the next set period ends the maximum and the minimum within the set period detected by the maximum detector circuit 16 and the minimum value detecting circuit 17 with the gating signal for output timing from the clock counting part 14. The maximum and the minimum which were held by this flip-flop circuit 20 for a maximum latch and the flip-flop circuit 21 for a minimum latch are sent to the MTF converter 22.
[0017]Although ROM23 for MTF conversion which has the table where the MTF calculation formula of the above-mentioned (2) formula was stored is used, RAM of this MTF converter 22, etc. are effective in addition to ROM. ROM23 for MTF conversion changes immediately into MTF the maximum and the minimum which were held by the flip-flop circuit 20 for a maximum latch, and the flip-flop circuit 21 for a minimum latch in hard on the above-mentioned table. Such operation is repeatedly performed with the cycle of the set period by the clock counting part 14, this is performed repeatedly every one scan of CCD12, and MTF of the specimen is calculated.
[0018]Therefore, since all the output data of CCD12 is processed in hard, it becomes possible to perform MTF measurement in real time for every scan. The MTF measurement in image height with all the arbitrary image height is attained that the chart 11 does not have the white level and black level of 0 spatial frequency, and by having formed the clock counting part 14 for time setting.
[0019]Thus, this example of an embodiment is an example of an embodiment of the MTF measuring device which applied the invention according to claim 1, In the MTF measuring device which carries out image formation of the image of the chart 11 which has a pattern of predetermined space frequency to CCD12 as solid scanning elements, carries out photoelectric conversion to it through the specimen, and calculates MTF of the specimen from the output data of these solid scanning elements 12, The output data of the solid scanning

elements 12 to the effective part of the chart 11 is sent to the maximum detector circuit 16 and the minimum value detecting circuit 17, The maximum and the minimum of said output data are made to output for every fixed time by the clock counting part 14 to these maximum detector circuits 16 and minimum value detecting circuits 17, Since MTF of the specimen is calculated in real time by hardware by changing this maximum and minimum into MTF by the MTF converter 22, high-speed MTF measurement is realizable. The high-speed adjustment which synchronized with MTF measurement is attained by the ability to perform MTF measurement in real time.

[0020]In the example of 1 embodiment of the MTF measuring device which applied the invention according to claim 2. In the above-mentioned example of an embodiment, it is the example which measured MTF of three colors of the specimen, for example, R, B, and G, and image formation is carried out on the solid scanning elements which consist of three-line CCD through the specimen which the chart 11 is illuminated with a light source and the image of the chart 11 becomes from the optical system of a tested lens etc.

[0021]Drive this three-line CCD with the clock from the clock generation part 13, and it carries out photoelectric conversion of each color component of the image of the chart 11, respectively, The maximum and the minimum for every color of that of each color of this three-line CCD from output data independently by the above-mentioned maximum detector circuit 16 and the minimum value detecting circuit 17, 3 same sets of maximum detector circuits and the minimum value detecting circuit, and the clock counting part 14. It is detected like **** and inputted into three MTF converters, respectively.

[0022]In order to prevent the error between each MTF of R by this three MTF converter not using the white level and black level of 0 spatial frequency, B, and G and to perform highly precise MTF measurement, It has the table stored, respectively, and what applied a correction factor which is mutually different in each color of R, B, and G to the MTF calculation formula of the above-mentioned (2) formula changes into MTF the maximum and the minimum which were inputted, respectively from the 3 above-mentioned sets of maximum detector circuits, and a minimum value detecting circuit, and amends them.

[0023]Namely, since the data of the white level of 0 spatial frequency and the data of the (maximum + minimum) / 2 <the median of width> differ from inclination of a between a little between each color of R, B, and G, In quest of the inclination, a correction factor is beforehand determined in an experiment, and they are MTF = (maximum-minimum) / {(maximum + minimum) /2} x correction factor instead of the MTF calculation formula of the above-mentioned (2) formula..... (3)

The table which stored the becoming MTF calculation formula is given to the three above-mentioned MTF converters. These MTF converters change into MTF of the specimen the maximum and the minimum which were inputted, respectively by (3) formulas.

[0024]Thus, in the example of an embodiment of the MTF measuring device which applied the invention according to claim 2. In the above-mentioned example of an embodiment, three-line CCD as solid scanning elements which performs photoelectric conversion of three colors to the effective part of the chart 11 is used as solid scanning elements, From the output data of these solid scanning elements, for every color A maximum detector circuit and a minimum value detecting circuit, Since it changes into MTF with the conversion factor which calculated the maximum and the minimum of said output data for every fixed time by the clock counting part, and set up independently the maximum and the minimum of these three classification by color for every color in the MTF converter, By amending between each color by MTF measurement of three colors of the specimen, the change of the chart at the time of using the white level and black level of 0 spatial frequency becomes unnecessary, and MTF measurement of all the image height can be performed with high degree of accuracy.

[0025]Although this invention is an example of the digital system which is not limited to the above-mentioned example of an embodiment, carries out the A/D conversion of the output data of CCD, and processes it, for example in the above-mentioned example of an embodiment, it is good also as an analog form which processes the output data of CCD with an analog value.

[0026]

[Effect of the Invention]As mentioned above, according to the invention according to claim 1, through the specimen, carry out image formation of the image of the chart which has a pattern of predetermined space frequency to solid scanning elements, and photoelectric conversion is carried out to them, In the MTF measuring method which calculates MTF of the specimen from the output data of these solid scanning elements, The output data of solid scanning elements to the effective part of said chart is sent to a maximum detector circuit and a minimum value detecting circuit, By making the maximum and the minimum of said output data output for every fixed time by a clock counting part to these maximum detector circuits and minimum value detecting circuits, and changing this maximum and minimum into MTF in an MTF converter, Since MTF of the specimen is calculated in real time by hardware, high-speed MTF measurement can be realized and the high-speed adjustment which synchronized with MTF measurement is attained.

[0027]In [according to the invention according to claim 2] the MTF measuring method according to claim 1, The solid scanning elements which perform photoelectric conversion of three colors to the effective part of said chart are used as said solid scanning elements, From the output data of these solid scanning elements, for every color A maximum detector circuit and a minimum value detecting circuit, Since it changes into MTF with the conversion factor which calculated the maximum and the minimum of said output data for every fixed time by the clock counting part, and set up independently the maximum and the minimum of these three

classification by color for every color in the MTF converter, By amending between each color by MTF measurement of three colors of the specimen, the change of the chart at the time of using the white level and black level of 0 spatial frequency becomes unnecessary, and MTF measurement of all the image height can be performed with high degree of accuracy.

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1]In an MTF measuring method which carries out image formation of the image of a chart which has a pattern of predetermined space frequency to solid scanning elements, carries out photoelectric conversion to them through specimen, and calculates MTF of specimen from output data of these solid scanning elements, Output data of solid scanning elements to an effective part of said chart is sent to a maximum detector circuit and a minimum value detecting circuit, By making the maximum and the minimum of said output data output for every fixed time by a clock counting part to these maximum detector circuits and minimum value detecting circuits, and changing this maximum and minimum into MTF in an MTF converter, An MTF measuring method calculating MTF of specimen in real time by hardware.
[Claim 2]In the MTF measuring method according to claim 1, solid scanning elements which perform photoelectric conversion of three colors to an effective part of said chart are used as said solid scanning elements, From output data of these solid scanning elements, for every color A maximum detector circuit and a minimum value detecting circuit, An MTF measuring method changing into MTF with a conversion factor which calculated the maximum and the minimum of said output data for every fixed time by a clock counting part, and set up independently the maximum and the minimum of these three classification by color for every color in an MTF converter.

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TECHNICAL FIELD

[Field of the Invention]This invention relates to the MTF measuring method which calculates MTF of the specimen using the chart which has a pattern of predetermined space frequency.

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PRIOR ART

[Description of the Prior Art]An MTF measuring method has an MTF measuring method which uses 0 spatial frequency, and an MTF measuring method which does not use 0 spatial frequency. The MTF measuring method which does not use 0 spatial frequency, Through the specimen, image formation of the image of the chart which has a pattern of predetermined space frequency is carried out to CCD (charge coupled device), photoelectric conversion is carried out to it, and it is MTF=(MAX-MIN)/(MAX+MIN-2xD) from the maximum MAX, the minimum MIN, and the dummy-bits data D of output data of this CCD.
MTF of the specimen come out of and defined is calculated.
[0003]To JP,S56-2516,A, the MTF measuring method which uses the white level and black level of 0 spatial frequency is indicated. In this MTF measuring method, through the specimen, image formation of the image of the chart which has a pattern of predetermined space frequency is carried out to CCD, photoelectric conversion is carried out to it, and as shown in drawing 5, the serial signal from this CCD is digitized by A/D converter 1, and is stored in RAM3 via the input/output port 2. Micro CPU4 performs digital calculation with the data in RAM3, and White level a and black level b of a required chart part, That is, it asks for white level A near the average value a of the signal of the several bits maximum of a white level field, the average value b of the signal of the several bits minimum neighborhood of a black level, and 0 spatial frequency, and black level B, and MTF of the specimen is calculated by MTF={(a-b)/(a+b)/(A-B)/(A+B)} x100% of an operation. If bit detection of two or more a, b, A, and B is carried out, respectively and each of those average value is substituted for the above-mentioned formula, the calculation precision of MTF will improve.
[0004]In the MTF measuring method which uses the white level and black level of 0 spatial frequency, when performing MTF measurement of all the image height, three kinds of charts of the white level of 0 spatial frequency and a black level, and the predetermined frequency for MTF measurement are required as a chart, and these charts are switched and used.

[0005]In measuring three colors of the specimen, for example, red, (henceforth [R]), and blue (henceforth [B]) and green (henceforth [G]) MTF, In the above-mentioned MTF measuring method, MTF is independently calculated about the output data of each color of this three-line CCD using three-line CCD which carries out photoelectric conversion of each color component of a chart image as CCD.

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EFFECT OF THE INVENTION

[Effect of the Invention]As mentioned above, according to the invention according to claim 1, through the specimen, carry out image formation of the image of the chart which has a pattern of predetermined space frequency to solid scanning elements, and photoelectric conversion is carried out to them, In the MTF measuring method which calculates MTF of the specimen from the output data of these solid scanning elements, The output data of solid scanning elements to the effective part of said chart is sent to a maximum detector circuit and a minimum value detecting circuit, By making the maximum and the minimum of said output data output for every fixed time by a clock counting part to these maximum detector circuits and minimum value detecting circuits, and changing this maximum and minimum into MTF in an MTF converter, Since MTF of the specimen is calculated in real time by hardware, high-speed MTF measurement can be realized and the high-speed adjustment which synchronized with MTF measurement is attained.
[0027]In [according to the invention according to claim 2] the MTF measuring method according to claim 1, The solid scanning elements which perform photoelectric conversion of three colors to the effective part of said chart are used as said solid scanning elements, From the output data of these solid scanning elements, for every color A maximum detector circuit and a minimum value detecting circuit, Since it changes into MTF with the conversion factor which calculated the maximum and the minimum of said output data for every fixed time by the clock counting part, and set up independently the maximum and the minimum of these three classification by color for every color in the MTF converter, By amending between each color by MTF measurement of three colors of the specimen, the change of the chart at the time of using the white level and black level of 0 spatial frequency becomes unnecessary, and MTF measurement of all the image height can be performed with high degree of accuracy.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]Even if the MTF measuring method which uses the chart which has a pattern of predetermined space frequency comprises hardware like an MTF measuring method given [above-mentioned] in JP,S56-2516,A, about the MTF operation, software is performing it. For this reason, it is difficult to perform an MTF operation at high speed, and had become a neck at the time of measuring MTF at high speed.
[0007]Since the white level and black level of 0 spatial frequency are not used for the MTF measuring method which uses the chart which has a pattern of predetermined space frequency, it cannot perform highly precise MTF measurement in the MTF measurement using three-line CCD. In the MTF measuring method which uses the white level and black level of 0 spatial frequency, there was a problem which can switch a chart or cannot take MTF of all the image height. An object of this invention is to provide the MTF measuring method which can realize high-speed and highly precise MTF measurement.

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MEANS

[Means for Solving the Problem]In order to attain the above-mentioned purpose, the invention according to claim 1, In an MTF measuring method which carries out image formation of the image of a chart which has a pattern of predetermined space frequency to solid scanning elements, carries out photoelectric conversion to them through specimen, and calculates MTF of specimen from output data of these solid scanning elements, Output data of solid scanning elements to an effective part of said chart is sent to a maximum detector circuit and a minimum value detecting circuit, By making the maximum and the minimum of said output data output for every fixed time by a clock counting part to these maximum detector circuits and minimum value detecting circuits, and changing this maximum and minimum into MTF in an MTF converter, MTF of specimen is calculated in real time by hardware.
[0009]The invention according to claim 2 uses solid scanning elements of 3 classification by color which performs photoelectric conversion of three colors to an effective part of said chart as said solid scanning elements in the MTF measuring method according to claim 1, From output data of solid scanning elements of these three classification by color, for every color A maximum detector circuit and a minimum value detecting circuit, The maximum and the minimum of said output data are calculated for every fixed time by a clock counting part, and it changes into MTF with a conversion factor which set up independently the maximum and the minimum of these three classification by color for every color in an MTF converter.
[0010]
[Embodiment of the Invention]Drawing 1 shows the example of 1 embodiment of the MTF measuring device which applied the invention according to claim 1, drawing 2 shows the concrete composition, and drawing 4 shows an overall hardware process flow. The chart 11 which has a pattern of only predetermined space frequency without the white level and black level of 0 spatial frequency as shown in drawing 3 is illuminated with a light source, and image formation is carried out on the solid scanning elements 12 which consist of CCD through the

specimen which the image of the chart 11 becomes from the optical system of a tested lens etc. CCD12 repeats the image of the chart 11, scans and (scan) carries out photoelectric conversion, and outputs it by a time series.

[0011]By the way, for the MTF measuring method which uses the white level and black level of 0 spatial frequency. From the white level and black level of the maximum of a required chart part and the minimum in the CCD output data to the chart which has a pattern of predetermined space frequency, and 0 spatial frequency to MTF=(maximum-minimum)/{(black level of white level 0 spatial frequency of 0 spatial frequency)} ... (1)

There is a method of calculating MTF of the specimen come out of and defined.

[0012]The data of the white level of 0 spatial frequency and the data of the (maximum + minimum) / 2 <the median of width> have correlation here, (1) since data of black level of 0 spatial frequency has dramatically small absolute value and contribution to (1) type is low type is MTF=(maximum-minimum)/{(maximum + minimum) /2}... (2)

It is possible for it to be alike and to replace.

[0013]Then, the chart 11 which has a pattern of only predetermined space frequency without the white level and black level of 0 spatial frequency is used for this example of an embodiment, and it calculates MTF of the specimen by the MTF operation of (2) types from the maximum and the minimum of output data of CCD12 to the effective part of the chart 11. That is, CCD12 is driven with the clock from the clock generation part (Clock) 13 at the set-up incorporation time, and incorporates and carries out photoelectric conversion of the image of the chart 11. The clock (Clock) counting part 14 counts the clock from the clock generation part 13, and generates the gating signal for output timing.

[0014]The counter circuit 15 where this clock counting part 14 consists of an IC for counters is used, and, as for this IC15 for counters, TTLIC is used. If IC15 for counters is TTL, it is more effective to use high-speed things, such as F type. The comparator circuit 18 for maximum detection and the comparator circuit 19 for minimum detection where the maximum detector circuit 16 and the minimum value detecting circuit 17 consist of a comparator IC, and the flip-flop circuit 20 for a maximum latch and the flip-flop circuit 21 for a minimum latch are used.

[0015]As for the comparator circuit 18 for maximum detection, and the comparator circuit 19 for minimum detection, it is also effective to use ROM, RAM, etc. instead of comparator IC. If the flip-flop circuit 20 for a maximum latch and the flip-flop circuit 21 for a minimum latch are TTL, it is more effective to use high-speed things, such as F type. The A/D conversion of the output data of CCD12 to the effective part of the chart 11 is carried out by the A/D converter which is not illustrated, The maximum detector circuit 16 and the minimum value detecting circuit 17 detect the maximum and the minimum of output data of the above-mentioned A/D converter within the set period (arbitrarily time which can be set up) set up by the clock counting part 14 with the gating signal for output timing from the clock counting part 14.

[0016]The flip-flop circuit 20 for a maximum latch, and the flip-flop circuit 21 for a minimum latch, It holds until the next set period ends the maximum and the minimum within the set period detected by the maximum detector circuit 16 and the minimum value detecting circuit 17 with the gating signal for output timing from the clock counting part 14. The maximum and the minimum which were held by this flip-flop circuit 20 for a maximum latch and the flip-flop circuit 21 for a minimum latch are sent to the MTF converter 22.

[0017]Although ROM23 for MTF conversion which has the table where the MTF calculation formula of the above-mentioned (2) formula was stored is used, RAM of this MTF converter 22, etc. are effective in addition to ROM. ROM23 for MTF conversion changes immediately into MTF the maximum and the minimum which were held by the flip-flop circuit 20 for a maximum latch, and the flip-flop circuit 21 for a minimum latch in hard on the above-mentioned table. Such operation is repeatedly performed with the cycle of the set period by the clock counting part 14, this is performed repeatedly every one scan of CCD12, and MTF of the specimen is calculated.

[0018]Therefore, since all the output data of CCD12 is processed in hard, it becomes possible to perform MTF measurement in real time for every scan. The MTF measurement in image height with all the arbitrary image height is attained that the chart 11 does not have the white level and black level of 0 spatial frequency, and by having formed the clock counting part 14 for time setting.

[0019]Thus, this example of an embodiment is an example of an embodiment of the MTF measuring device which applied the invention according to claim 1, In the MTF measuring device which carries out image formation of the image of the chart 11 which has a pattern of predetermined space frequency to CCD12 as solid scanning elements, carries out photoelectric conversion to it through the specimen, and calculates MTF of the specimen from the output data of these solid scanning elements 12, The output data of the solid scanning elements 12 to the effective part of the chart 11 is sent to the maximum detector circuit 16 and the minimum value detecting circuit 17, The maximum and the minimum of said output data are made to output for every fixed time by the clock counting part 14 to these maximum detector circuits 16 and minimum value detecting circuits 17, Since MTF of the specimen is calculated in real time by hardware by changing this maximum and minimum into MTF by the MTF converter 22, high-speed MTF measurement is realizable. The high-speed adjustment which synchronized with MTF measurement is attained by the ability to perform MTF measurement in real time.

[0020]In the example of 1 embodiment of the MTF measuring device which applied the invention according to claim 2. In the above-mentioned example of an embodiment, it is the example which measured MTF of three colors of the specimen, for example, R, B, and G, and image formation is carried out on the solid scanning elements which consist of three-line CCD

through the specimen which the chart 11 is illuminated with a light source and the image of the chart 11 becomes from the optical system of a tested lens etc.

[0021]Drive this three-line CCD with the clock from the clock generation part 13, and it carries out photoelectric conversion of each color component of the image of the chart 11, respectively, The maximum and the minimum for every color of that of each color of this three-line CCD from output data independently by the above-mentioned maximum detector circuit 16 and the minimum value detecting circuit 17, 3 same sets of maximum detector circuits and the minimum value detecting circuit, and the clock counting part 14. It is detected like **** and inputted into three MTF converters, respectively.

[0022]In order to prevent the error between each MTF of R by this three MTF converter not using the white level and black level of 0 spatial frequency, B, and G and to perform highly precise MTF measurement, It has the table stored, respectively, and what applied a correction factor which is mutually different in each color of R, B, and G to the MTF calculation formula of the above-mentioned (2) formula changes into MTF the maximum and the minimum which were inputted, respectively from the 3 above-mentioned sets of maximum detector circuits, and a minimum value detecting circuit, and amends them.

[0023]Namely, since the data of the white level of 0 spatial frequency and the data of the (maximum + minimum) / 2 <the median of width> differ from inclination of a between a little between each color of R, B, and G, In quest of the inclination, a correction factor is beforehand determined in an experiment, and they are MTF = (maximum-minimum) / {(maximum + minimum) /2} x correction factor instead of the MTF calculation formula of the above-mentioned (2) formula..... (3)

The table which stored the becoming MTF calculation formula is given to the three above-mentioned MTF converters. These MTF converters change into MTF of the specimen the maximum and the minimum which were inputted, respectively by (3) formulas.

[0024]Thus, in the example of an embodiment of the MTF measuring device which applied the invention according to claim 2. In the above-mentioned example of an embodiment, three-line CCD as solid scanning elements which performs photoelectric conversion of three colors to the effective part of the chart 11 is used as solid scanning elements, From the output data of these solid scanning elements, for every color A maximum detector circuit and a minimum value detecting circuit, Since it changes into MTF with the conversion factor which calculated the maximum and the minimum of said output data for every fixed time by the clock counting part, and set up independently the maximum and the minimum of these three classification by color for every color in the MTF converter, By amending between each color by MTF measurement of three colors of the specimen, the change of the chart at the time of using the white level and black level of 0 spatial frequency becomes unnecessary, and MTF measurement of all the image height can be performed with high degree of accuracy.

[0025]Although this invention is an example of the digital system which is not limited to the above-mentioned example of an embodiment, carries out the A/D conversion of the output data of CCD, and processes it, for example in the above-mentioned example of an embodiment, it is good also as an analog form which processes the output data of CCD with an analog value.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a block diagram showing the example of 1 embodiment of the MTF measuring device which applied the invention according to claim 1.
[Drawing 2]It is a block diagram showing the concrete composition of the example of an embodiment.
[Drawing 3]It is a figure showing the chart and CCD output data of the example of an embodiment.
[Drawing 4]It is a flow chart which shows the overall hardware process flow of the example of an embodiment.
[Drawing 5]It is a block diagram showing an example of the conventional MTF measuring device.
[Description of Notations]
11 Chart
12 CCD
13 Clock generation part
14 KUROKKAUNTO part
16 Maximum detector circuit
17 Minimum value detecting circuit
22 MTF converter

[Translation done.]

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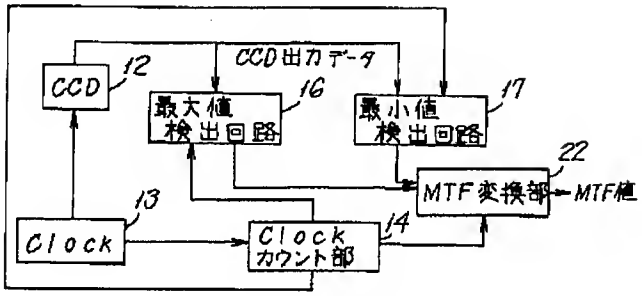
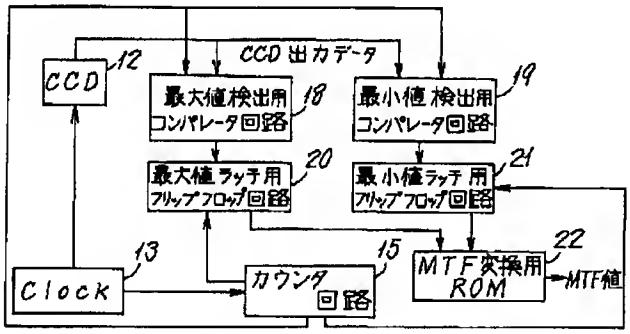
DRAWINGS

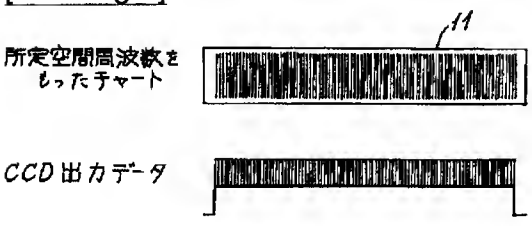
[Drawing 1]



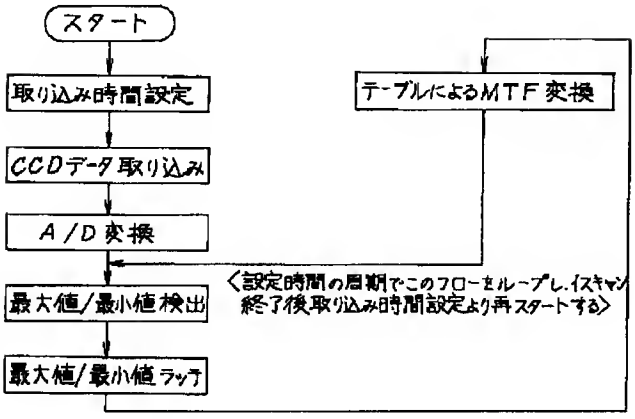
[Drawing 2]



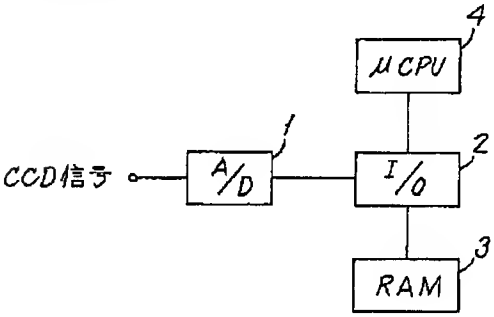
[Drawing 3]



[Drawing 4]



[Drawing 5]



[Translation done.]